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ABSTRACT

This paper examines problems involved in designing an integrated system to teach and assess critical thinking skills in the classroom, and describes the Monitor Achievement in Pittsburgh (MAP) Critical Thinking Project, an attempt to draw upon research from diverse disciplines in developing an effective pilot project in the Pittsburgh public school system. After a brief description of the MAP project, literature is reviewed which bears on the problem of designing critical thinking programs in general, and on the form of this project in particular. Topics include (1) definitions of critical thinking, (2) analyses of critical thinking, (3) elements of cognition, and (4) critical thinking and problem solving. The MAP Critical Thinking Project's developing concept of critical thinking is then defined, followed by a discussion of the assessment component, implications of cognitive learning research for instructional design, approaches to critical thinking instruction, and the institutional context. Resources for teaching critical thinking in the classroom are reviewed, and past curriculum projects are described. The paper concludes by emphasizing the challenge of designing an integrated system for critical thinking and the need for systematic study of effective teaching strategies. (TE)

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DESIGNING AN INTEGRATED INSTRUCTIONAL AND ASSESSMENT SYSTEM FOR CRITICAL THINKING SKILLS

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The desire to teach students to form reasoned interpretations and evaluations of their academic and personal experiences pervades educational rhetoric. The philosopher, Mortimer Adler, has called for renewed emphasis on critical thinking; the New York Times devoted an educational supplement to new critical thinking efforts, and even the Reader's Digest recently featured an article on how to think better!

Clearly, the public expects schools to teach students to think, not simply to absorb subject-matter content. Although courses of study for most school subjects contain goals for teaching inference and criticism, and periodically there are special projects that attempt to develop critical thinking skills, for the most part, these efforts have had little success in producing classroom activities teachers will use systematically. Not too surprisingly, evidence is mounting that students' interpretative and evaluative skills are not well developed. The results of students' reading, thinking and writing skills by the National Assessment of Educational Progress (NAEP) indicated that few students at any age level could write essays in which they formed and explained interpretations of reading passages (NAEP, 1981).

The problems plaguing attempts to establish critical thinking classroom instruction are varied and formidable. There is little consensus on what critical thinking is, on how to teach it or on how to measure its outcomes. Furthermore, despite the lip service paid to the need for instruction on higher-order reasoning skills, teachers and students may view critical thinking curricula as tangential to required courses of study, as appropriate only for high ability students, or as too demanding of time and effort. To compound the problem, administrative and economic support for projects has often been too weak or short-lived to permit sustained critical thinking instruction to become an established classroom routine.

The purpose of this paper is to examine some of the problems involved in designing an integrated system to teach and assess critical thinking skills in the classroom and to describe attempts to draw upon research from diverse disciplines to inform the development of an effective, viable pilot project in the Pittsburgh public school system.

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Background of the Monitor Achievement in Pittsburgh (MAP) Critical Thinking Project

Before reviewing research and theory that influenced the initial design of the MAP Critical Thinking Project, it is important to know the events and perspectives that instigated it. The design of the Critical Thinking Project in the Pittsburgh Public Schools was forged by two major forces: the commitment of the superintendent, Richard C. Wallace, to use a mastery learning approach to improve student achievement, and our conviction that a program in which students wrote about what they read could provide a powerful framework for developing disciplined critical skills, as well as reading and writing skills. The charge to superintendent from the school board was to lead the development of a plan to improve achievement; a component of his strategy was to draw upon Bloom's mastery learning model to focus, structure and coordinate instruction, assessment, and staff development efforts (Bloom, 1968). Part of the assessment component was to be a district-wide diagnostic assessment system administered every six weeks, to Monitor Achievement in Pittsburgh (MAP). Our project joined other MAP projects in math, writing, and reading to extend development of critical thinking skills.

In the project, we have developed three separate, but coordinated components. The assessment component includes a set of diagnostic tests that ask students to write compositions about a reading passage. Teachers use a rating guide to provide analytic feedback to students on how well their compositions had a clear main point, adequate support and logical organization. The instructional component suggests general teaching strategies and provides model lessons. The staff development approach is used in the other MAP programs. During the staff development sessions, teachers work with project staff using research-based techniques to develop, interpret and revise project procedures and materials.

In 1982, we initiated the project with approximately 35 fifth, eighth and eleventh-grade English and language arts teachers. The goal of the six-month pilot project was to develop prototype strategies and materials. In the fall of 1983, the project moved out of language arts into social studies. We began working with approximately 25 teachers from the same grade levels to adapt the language arts prototypes to social studies. The project's development is still very fluid and formative. With this in mind, the paper will review some of the literature that bears on the project's form and substance, in particular, and on problems of designing critical thinking programs, in general.

Definitions of Critical Thinking

As a generic term, "critical thinking" seems to strike a common chord of understanding. A close inspection, however, reveals that the general term translates into quite varied sets of classroom activities that call upon diverse cognitive processes and knowledge structures.

Three related, but separate bodies of literature seem to have produced the major concepts of critical thinking. In one approach, writers set out to define critical thinking and deduce more (or less) insightfully, the skills assumed to comprise the construct of critical thinking. Proposed taxonomies or hierarchies of learning that include skills related to critical thinking as part of their more general analyses of cognitive complexity are a second source. A third source is the literature on inquiry and problem solving skill development. Work in each of these areas has influenced specification of the skills proposed for critical thinking, the features of tasks used to teach and test critical thinking, and the instructional approaches advocated for developing these skills.

Analyses of Critical Thinking

A number of writers have proposed definitions and analyses of the critical thinking construct. Some of these writers have looked to philosophies of logic and rhetoric to identify generalized thinking skills; other writers have looked to the epistomology of a subject domain to identify specific interpretive and evaluative skills; another group has derived its constructs from syntheses of various perspectives; and a final group has simply announced ad hoc definitions and skill lists.

Dewey's discussion of "reflective thinking" in his book How We Think, is a frequently cited definition of general critical thinking skills that transcend the particular conventions of subject domain (Dewey, 1933). Dewey defined reflective thinking as the careful and persistent examination of an action, proposal or belief, and the analysis or use of knowledge in light of grounds which justify it and its probable consequences. He also proposed a five-step process that the critical thinker would use: 1) identify a problem, 2) analyze a problem, 3) suggest possible solutions, 4) test consequences, and 5) judge the selected solution.

Another pioneer in the analysis and evaluation of generalized critical thinking skills, Edward Glaser, proposed three components of critical thinking: 1) an attitude of being disposed to consider in a thoughtful way the problems and subjects that come within the range of one's experiences, 2) knowledge of the methods of logical inquiry and reasoning, and 3) some skill in applying these methods (Glaser, 1941).

B. O. Smith also emphasized the judgmental dimensions of critical thinking is his definition, but limited their application to problems of logical reasoning presented to the student, i.e., "what a statement means and whether to accept to reject it" (Smith, 1953). In his landmark paper, "A Concept of Critical Thinking," Ennis further elaborated Smith's view of critical thinking by delineating twelve skills involved in the "correct assessment of statements." Ennis's skills primarily called for the application of rules of formal and informal logic, including making judgments about the logic, validity, reliability and sufficiency of assertions and their underlying assumptions (Ennis, 1962).

Other concepts of critical thinking have attempted to consider its role in particular school subjects. Russell, for instance, discussed the relationship of critical thinking to the development of students' reading skills. The eight skills he identified are still fairly representative of the lists of objectives commonly classified as inferential or critical reading skills. They include abilities to: 1) abstract and organize information, 2) draw inferences, 3) search for relevant materials, 4) evaluate data, 5) compare sources, 6) distinguish fact from opinion, 7) detect propaganda, and 8) apply rules of logical reasoning (Russell, 1965).

Thomas, too, expanded the constellation of critical thinking skills from logical reasoning. Following an extensive review of critical thinking concepts and instruction by Thomas and Taylor (1975), Thomas proposed as an operational definition that critical thinking involved the use of logical or pragmatic criteria in assessing the reliability, relevance, sufficiency, validity or meaning of information and also the use of evaluation strategies (Thomas, 1973).

Hudgins also reviewed conceptualizations of critical thinking skills and attempts to teach them. He extracted four attributes common to the notions of critical thinking he had analyzed: 1) comprehension, 2) use of evidence, 3) evaluation of evidence and lines of reasoning, and 4) awareness of assumptions (Hudgins, 1977). In his view, critical thinking was "a general attitude of searching for evidence relevant to conclusions and that attitude must be supported by an array of intellectual skills germane to the analyzing and evaluation of arguments" (p. 179).

In a recent review of varying concepts of critical thinking, McPeck offers an extensive and thoughtful analysis and critique of prevailing views. McPeck dismisses attempts to equate critical thinking and formal logic as inappropriately rigid and narrow (McPeck, 1981). He also marshalls considerable support for his thesis that critical thinking rests upon field dependent epistomology, i.e., knowledge of the belief systems of a discipline that provide rationales for allowable, legitimate moves from data to conclusions. In McPeck's view, "When a person knows how to suspend judgment for the purpose of using his epistemic understanding of an issue, and does in fact do so, we say of that person that he is a critical thinker" (p. 156).

Throughout these conceptualizations of critical thinking run some common skills. These include: 1) an attitudinal component, suggesting an awareness, a disposition to be reflective; 2) an analytical component involving the identification of relevant information; 3) a component for weighing evidence; 4) a component involving knowledge of pragmatic and formal methods of reasoning; and 5) the act of evaluation. These analyses of critical thinking propose hypothetical constructs that call for empirical investigation. Few of these constructs have been subjected to sustained inquiry, however.

Elements of Cognition

Schemes for classifying and sequencing components of cognitive complexity also serve as frameworks for discussions of critical thinking. In contrast to definitions of critical thinking derived from intuitive and logical analyses, many of the proposed taxonomies and skill hierarchies have arisen from or led to empirical studies. Interpretations conflict, however, over the validity of experimental tasks and findings and their relevance to attempts to define or teach critical thnking in classrooms.

Piaget's stages of development, particularly the distinction between formal and operational thought, are often used to differentiate among problems requiring critical thinking and also to interpret performance (Inhelder & Piaget, 1958). Critics of this line of research contend that the artificial nature of the tasks makes it difficult to construct realistic or academic classroom critical thinking activities that would elicit parallel cognitive operations (Estes, 1978).

Guilford's Structure of the Intellect has also influenced concepts of critical thinking. Four factors relating to some of the 120 proposed intellectual abilities are hypothesized to underlie critical thinking: cognition, evaluation, convergent and divergent production (Guilford, 1956).

Gagne's learning hierarchy is yet another source for analyses of critical thinking. The upper levels of the hierarchy, where students use concepts, rules, and problem-solving skills, have been considered as skill elements of critical thinking (Gagne, 1977).

Bloom's taxonomy of cognitive objectives is the classification scheme most familiar to teachers and most used as a heuristic for defining critical thinking goals. The levels of application, analysis, synthesis and evaluation have been used repeatedly to differentiate among levels of objectives, questions, and instructional activities (Bloom, 1971).

More recently, Craik and Lockhart's notions of depth of processing have stimulated studies of how learners process information. In their scheme, deeper processing and therefore increased learning occurs when learners draw connections among pieces of presented information. By implication, higher levels of thinking are characterized by both the number and type of relationships or semantic networks formed (Craik & Lockhard, 1972).

Sternberg has also suggested a heirarchy of cognitive performances including the components of inductive reasoning, encoding, inferring relationships between terms, mapping higher order relations, applying previously learned relations to new settings, comparing alternative answer options, justifying one answer and combining elements into strategies (Sternberg, 1981; 1983).

Only some of these analyses of elements of thinking or cognition pertain to concepts of critical thinking. Some notions of critical thinking that reference the upper levels of these heirarchies, for example, do not seem to distinguish complex reasoning from the "critical" evaluative aspect.

Critical Thinking and Problem Solving

The line of research on inquiry and problem solving also relates to concepts of critical thinking. While typologies of thinking or cognition focus on identifying kinds of mental operations and their relative complexity, inquiry/problem solving research focuses more on the patterns and sequences in which these component skills are used to solve problems. Theory and research in the problem-solving literature is probably the most advanced in helping to differentiate generalized problem-solving skills from procedures and heuristics unique to the epistomology of a discipline. Research on the processes experts use is providing evidence of a separate, executive program, i.e., experts' self-conscious supervision of the strategies they use as they plan, execute, monitor and revise the procedures they are using to solve a particular task (Chi, Glaser, & Rees, 1982; Simon, 1981).

In definitions of problem solving or inquiry, skills such as weighing evidence and making judgments or drawing conclusions also appear. This literature adds to an identification of skill components and how they are acquired and implemented. Discovery of problems and explanation of alternative solutions are stressed. Within this paradigm, Bruner, for example, stressed the value of having students use the particular inquiry methods of academic disciplines. He identified a set of inquiry skills that included getting and using information, going beyond given information and understanding what makes that possible. He also asserted that children should be at least as self-conscious about their strategies of thought as they are about their attempts to commit things to memory (Bruner, 1966, p. 95).

Suchman stressed the value of an inquiry process that is initiated and controlled by the learner. His main goal was for students to be conscious of the inquiry process. Components of that process included the analytical skills of verification and experimentation and the inferential skills developed by questions of necessity and synthesis (Suchman, 1965).

For Covington, divergent thinking involved in the inquiry process was so important that he deliberately addressed analytic, synthetic and evaluative skills in non-traditional subject areas (Covington, 1968).

Taba, on the other hand, grounded development of the inquiry skills of concept formation and inference and application of principles in a social studies curriculum (Taba, 1963). In a review of inquiry-oriented curricula, Cornbleth identified six elements of inquiry: 1) doubt, 2) clarification, 3) hypothesizing, 4) reasoning, 5) testing, and 6) reaching conclusions (Cornbleth, 1978).

One of the most profound influences on current efforts to conceptualize and teach cognitive skills and on our project's initial efforts to formulate a working definition and framework for critical thinking was the work of Newell and Simon (1976). Their studies have indicated that problem-solving involves recursive attempts to discover a match between things mentioned in a problem statement and the schema and operations stored in memory. As Simon describes the process, the problem solver first must understand the problem, then activate a process of detecting differences, finding relevant operators, applying the operators and evaluating progress. Eventually, the expert routinely recognizes the situation (problem type) and the appropriate pattern of "moves" (Simon, 1981).

These analyses of problem solving have exerted considerable influence on methods used to study the processes skilled and unskilled readers and writers use to understand and produce discourse. For example, planning, construction, evaluating and revising have been used to characterize reading and writing processes (Brown, Campione & Day, 1981; Hays & Flower, 1979; Scardamlia & Bereiter, in press).

Also, researchers in these areas have attempted to describe more consistently the elements of "problem types" presented to readers and writers by turning to theories of discourse structure (Kinneavy, 1971; Toulmin, 1958) and by developing discourse analysis schemes (Meyer, 1975). Toulmin's analysis of the argumentative mode is particularly useful for identifying elements that students would include in their expression of a critical thinking task (their essays). Toulmin proposes that all arguments have essentially the same structure and offers a "lay out" of the components of practical argument. The structure includes: 1) claims-- a position or generalization, 2) data--evidence, 3) warrants--explanations of how data relate to the position, 4) backing--explanation of conditions, and 5) reservations and qualifers--indications of the writer's degree of conviction (Toulmin, 1958). When students are asked to explain their evaluations and interpretations in classroom activities, then, we might at least expect them to use the elements of claim, data and warrants.

Research on problem solving has developed along with a theory of information processing. The coordinated theoretical and empirical work in this area form a very credible framework for defining and developing critical thinking skills.

The MAP Critical Thinking Projects' Developing Construct of Critical Thinking

As we initiated the project in the language arts domain, our working definition of critical thinking was that critical thinking is a deliberate act in which students select from alternative strategies to achieve a purpose. We further proposed that critical thinking develops in the skill domains of reading and writing as students learn to analyze and evaluate text. We have continued to adapt those views

as we design project components to fit within the social studies curriculum.

From the preceding review, we can see that a modified working definition and framework for teaching and assessing critical thinking can draw from each of the bodies of literature. From analyses of critical thinking as a "problem type," emerge a set of defining characteristics of critical thinking. First, to be "critical," thinking tasks or problem types seem to be those that call for making a judgment, drawing a conclusion or forging a relationship. Thus, the goal of critical thinking instruction might be described as the "expression and explanation of an assertion." Furthermore, we would expect the discussion or essay in which a student expresses and explains his interpretation or evaluation of text to contain at least the basic structural elements of a well-formed argument, i.e., a claim (main point), data (evidence), and warrants (explanations of the relevance of evidence to the claim). As McPeck suggests, the task should permit more than one justifiable answer and the good answer should be judged on the quality of the justification (McPeck, p. 149).

If we refer to taxonomies of learning, we can extract from them some key component skills which students would seem to need to master in order to form and defend their positions. These include component skills or operators such as comprehension/verification of required information and bases and strategies for classification and inferences. Furthermore, these component skills may serve as enabling skills for fashioning and explaining the end goal, and evaluation or judgment. Finally the problem-solving literature suggests that a set of conscious, recursive, basic strategies underlie the development and self-regulation of critical thinking processes: The meta-cognitive processes of planning, constructing, evaluating and revising.

A definition of critical thinking that uses terms familiar to parents, teachers and students, might be, "the deliberate process of constructing and explaining interpretations and evaluations." The elements we expect students to include in their constructions are: topic statements, credible evidence, explanations, and conclusions. The process of critical thinking involves: planning, constructing, evaluating and revising strategies; skill domains or "problem types" might include: summarizing, classifying, inferring, and evaluating.

Furthermore, for the critical thinking process to become a routine approach, the processes of planning constructing, evaluating, and revising should serve two functions, 1) to help students develop habitual patterns of approaching critical thinking tasks, and 2) to help students develop a reflective, self-monitoring strategy for thinking about how they successfully use these processes.

Assessment of Critical Thinking

A number of factors influenced our design of the assessment component. First, we came to the project sharing the district's

commitment to the view of assessment as an integral part of the instructional system. We were in complete accord with the other MAP projects and the mastery learning model that the function of the assessment was to monitor progress, diagnose problems, inform instructional decision making and provide formative evaluation for program improvement.

One implication of this view is that testing should match instruction--what Skinner had described as one more unprompted trial of the terminal behavior (Skinner, 1968). Like the instructional activities, then, the assessment must also permit students to construct and explain their interpretations and evaluations of what they read.

In order to design assessment forms for each of the skill areas (summarize, classify, infer, evaluate), we drew from methods of domain referenced testing, i.e., defining the characteristics of text passages and questions that would guide writing the tests (Baker, 1974; Hively, 1974; Popham, 1978; Quellmalz, 1978). One of our goals for the project was to specify task domains so that we could develop a homogeneous pool or bank of activities that could be used for instruction or assessment.

Another implication of the view of testing in the service of instruction is that the diagnostic function would provide maximum information by presenting an analytic profile of the essay. Therefore, the project adapted the hybrid holistic/analytic rating strategy developed as part of the Writing Assessment Project at the Center for the Study of Evaluation (Quellmalz, Capell, & Chou, 1982). The intent of the guide is to provide information on the essay components of focus, support and organization, as well as a holistic judgment of how well the essay orchestrates these components to address the assignment (Quellmalz, 1981). The resulting score profile enables teachers to focus class and individual instruction on areas requiring further development.

Critical Thinking Instruction

As we might expect, the broad spectrum of critical thinking definitions has fostered a variety of attempts to teach these skills. Some instructional efforts focus on strategies for critical thinking systemic to a particular discipline, others allege they promote generalizable critical thinking skills. Programs differ in their scope, as well as in the nature and amount of support they provide in the way of teaching strategies and instructional activities. Critical thinking projects also vary considerably in their attempts to link teaching procedures to instruction and assessment. Unfortunately, data documenting a programs's implementation and effectiveness are often absent, incomplete or based on poorly developed or selected measures.

The design of the instructional component draws from the literature of instructional design and learning research those techniques which had the strongest research base supporting their usefulness in teaching

complex reasoning skills in the classroom. Although our general approach incorporates techniques drawn from learning theory and research, the specific instructional strategies and material formats continue to evolve from our collaboration with district teachers and staff.

Implications of Cognitive Learning Research for the Design of Critical Thinking Instructions

Critics of the behavioral model for designing instruction have objected to its tendency to focus on lower-level skills and to its view of learning as a passive, input-output process. Cognitive psycologists have rejected the emphasis of behaviorism on overt, observable responses at the expense of covert, hypothetical mental operations and knowledge structures that combine to produce observable responses. Cognitive psychologist's view of learning as a constructive, generative process in which the learner assimilates new information into existing knowledge frameworks or schemata has produced research findings which are particularly relevant to the design of critical thinking instruction.

First, the cognitive paradigm revives the distinction between the psychological processes involved in recognition vs. production and corroborates the greater diagnostic value of constructed response measures--a distinction particularly important to critical thinking information.

Second, studies of instruction in text comprehension (e.g., Brown, Campione & Day, 1981), and writing (e.g., Scardamalia & Bereiter, in press), reveal that students can learn to improve their planning, executing, monitoring, or revising skills. There has been less classroom research however on improvements in domain-independent, meta-cognitive skills where students "step back" and reflect on the state of their own knowledge base and strategies available to face task demands. These meta-cognitive skills are similar to the self awareness Bruner recommended that children should have about their own strategies of thought (Bruner, 1966).

The implications of cognitive research for critical thinking instruction, then, are that students might well benefit from instructional activities in which they practice and receive explicit guidance in strategies they might use to plan, construct, assess and revise their interpretations and evaluations. Furthermore, these instructional and assessment activities should emphasize constructed responding and still use the core instructional techniques of orienting stimuli, instructional cues (particularly modelling), practice and feedback. These instructional variables continue to surface as effective techniques in cognitive training studies (e.g., Brown, Campione, & Day, 1980).

Approaches to Critical Thinking Instruction in the MAP Critical Thinking Project

Our general instructional approach has been to design lessons where students express their understandings, interpretations and evaluations

of passages by engaging in the process of planning, "doing," (i.e., reading, discussing, writing), evaluating and revising. Typically, students are presented with a writing or discussion assignment for one of the four skill areas (summarizing, classifying, inferring or evaluating). Following the techniques of Hunter's lesson design model, students are presented with the objective of the lesson in order to focus their attention on the goal. Before reading, the teacher may "elicit appropriate schemata" through an introductory discussion of students' background information about the content of the passage and, when appropriate, its source, (e.g., a biased observer) or structure (e.g., an editorial or a diary entry). Students plan to read by using strategies to determine what information in the passage would be most relevant to the writing assignment. After reading, students review passage content to check for comprehension, then engage in a variety of planning-to-write activities that include discussing and outlining relevant evidence. The students write the essay, it is evaluated by the teacher or students according to scoring guide criteria and may be followed by a revision activity focused on one or more elements of the essay or on the procedures students used to find and incorporate appropriate information in the essay. The instructional techniques of teacher input (cues and models), practice and feedback then are included in the model lessons as they are appropriate to the class's skill development level.

A major contribution of cognitive research to our approach to designing the instructional and testing systems has been the notion of distinguishing among task or problem types. Like the specification of assessment problems, instruction on critical thinking, then, must precisely link the required "thinking" skills to the bounded problem domain.

The Context of Critical Thinking Instruction

Perhaps one of the most essential, yet neglected factors in the design of a critical thinking program is the institutional context in which the program must operate. Many of the innovative programs developed in the 1960's failed to survive after specialized support and funding ceased. This may have been due, in part, to the programs' failure to consider aspects of the organizational context.

At the classroom level, the problems could include a cumbersome managerial system, an orientation at odds with the philosophies of the teachers or curriculum, or content that is viewed by teachers and/or students as tangential to required course goals or that is considered boring or irrelevant. Also the program may not provide sufficient guidelines, supporting materials or consulting help. Conversely, the program may have been designed to be so "teacher proof" that the activities do not permit sufficient flexibility to meet the needs of different teaching styles and groups of students.

Studies of the implementation of innovative programs at Rand and analyses of implementation data from the Follow Through Project

indicated that variations in the use of a single program within each site were as great as variations between sites (Berman & McLaughlin, 1977; Kennedy, 1978). The implication of these findings is that teaching procedures must provide enough support for teachers to use them as they are, yet enough flexibility to allow teachers to tailor their instruction to their classes. Another implications is that involving classroom teachers who are in the operating system in the development of the instructional system may help assure program appropriateness and acceptance. The MAP projects use such a collaborative strategy as one of their development techniques.

At the school and district levels, the program may not receive the support of administrative staff. This may be the result of poor communications or the lack of support for the program from other levels of the administration. In Pittsburgh, the MAP projects address skills identified in a district-wide needs assessment and then mandated by the school board. Therefore, they receive full administrative support. In fact, we are fortunate that Pittsburgh's district context has many of the features Bank and Williams (1981) describe as characteristics of "heroic" districts that manage to use testing to improve instruction. Some of these features are: 1) the support of anidea champion, 2) a commitment to testing in the service of instruction, 3) and a strong staff development program.

In sum, program failure can often be traced to context insensitivity. By developing the project within the school district, we are trying to build a program sensitive to district concerns and strengthened by the talent and expertise of its personnel.

Analysis of Resources for Teaching Critical Thinking in the Classroom

The review of resources available for teaching critical thinking in the classroom, examines several elements: 1) the skills proposed as elements of critical thinking, 2) the kinds of tasks set to elicit the skills, 3) the inter-relationships of teacher training, instructional materials and assessment, 4) use of research-based instructional techniques used to teach the skills in relation to ones which we had identified with a research base, 5) the role and structure of assessment activities, and 6) whether there was evidence of the effectiveness of skills development, variations in instruction, and acceptance by teachers and students.

Resources developed to teach critical thinking skills in the classroom vary along a number of dimensions. One dimension is the intended function of the resource. The resource may be a curriculum project which presents teachers with strategies and activities to achieve a set of specified outcomes. These projects can further be differentiated into ones embedding critical thinking within a standard school subject such as science or social studies, or ones designed to teach generalized critical thinking skills.

In-service, staff development programs are another set of resources developed to help teachers teach critical thinking in the classroom. These staff development projects may also either focus on a variety of techniques for teaching critical reasoning skills, or be limited to questioning techniques.

Some textbooks present guidelines for teaching critical thinking. These may review critical thinking concepts and studies of critical thinking and describe exemplary techniques. Others present one particular program. A third text type presents questioning strategies.

The last resource materials are courses of study and sets of objectives. These materials differ in the range and interrelationship of critical thinking skills proposed, in focus, and in the amount of guidance and supporting information they present for instructional strategies and activities.

Because of the array of resources potentially relevant to critical thinking instruction, this review only considers curriculum projects with certain characteristics. Of most interest are resources designed to be used by teachers and students and that attempt to deliberately train the development of critical thinking skills. Although some of the particular techniques and instructional materials in the other resources may have implications for classroom lessons, experience also suggests that teacher workshops or courses of study and textbooks, in isolation from on-going curricula, have a low probability of classroom application.

Unfortunately, in many cases, copies of the manuals and student and teacher materials of curriculum programs were not available as primary sources for these programs. Therefore, this review often had to rely on descriptions of the projects in secondary sources. These descriptions often did not provide information about important program features. In the aggregate, however, the program descriptions allowed reasonable comparisons between the initial design of the MAP Critical Thinking pilot project and other efforts to teach critical thinking in the classroom.

Curriculum Projects

A number of curriculum projects have attempted to foster critical thinking. Hudgins (1977) reviews studies from the 1930's and the 1940's. He describes a program designed by W. Glaser in 1941. Glaser developed a semester English course of eight units promoting skills related mostly to logic or detecting propaganda. The program was inserted into a regular English curriculum, but the materials were only remotely related to the usual method of analyzing essays and newspapers. Hudgins does not describe the nature of the materials or the instructional techniques other than to indicate that Glaser provided a complete set of materials and references for reading. Apparently, with "careful planning" the teacher could present a self-contained critical thinking program. In

Glaser's study of the program, the experimental classes outperformed control classes on an undescribed test. No information about teacher and student reactions to the program was reported.

In the 1960's and early 1970's a number of curriculum projects appeared using an "inquiry" approach. Among those using the approach to help students develop skills in the scientific method were the Biology Science Curriculum and the AAA Science: A Process Approach. These projects usually presented students with laboratory activities where students "discovered" scientific principles of the subject domain. Evaluations of these projects did not appear in the published literature, although a few writers suggested that the programs' procedures often distracted students from the intended outcomes because students became fascinated with the laboratory equipment. Critics also felt that the discovery processes were unnecessarily time-consuming.

Suchman's Inquiry Training Program (1965) was a fairly well-documented inquiry-oriented science program. The program was designed to help sixth-grade elementary students discover basic physics principles. The 24 weeks of instruction presented film clips demonstrating physical phenomena which students first watched and then tried to explain. Students then asked a series of "disciplined" questions. During the three stages of a lesson, students were encouraged to ask verification quesitons during episode analysis (understanding elements of the problem), questions to determine relevance during the next stage and, finally, inferential questions trying to induce relational constructs. The teacher's role was to provide feedback through "yes" and "no" replies. The program had an eight week inservice program to train teachers how to interact during the lessons. The progam measured its outcomes by looking at students' conceptual mastery and application of the physics principles and by analyzing protocols of the questions students asked about a film. Students in the experimental classes only outperformed control classes (which had viewed the same film but were taught the principles directly) in the number of verification questions and in the total number of questions asked. These results provide some weak evidence that students can be encouraged to self-initiate initial portions of the inquiry, information seeking process.

Social studies is another subject in which curricula tried to foster critical inquiry. Bruner's Man, A Course of Study, was one such program; Taba's elementary social studies program is perhaps most often cited. Taba's program emphasized social studies concepts and inferences. Teacher training was carefully designed to reinforce procedures in the curriculum and criterion-referenced program tests were developed. In a year-long field study, experimental classes did not significantly outperform control groups, but methodological problems in the conduct of the evaluation may have obscured differences. In addition, the evaluation did not collect observations or interview/questionnaire data about the implementation of the instruction, therefor, it was difficult to interpret results.

Other curriculum projects couched their instruction on critical thinking in non-school subjects. Covington's Productive Thinking

Program followed the general approach of the other inquiry programs, but was purposely divorced from traditional subjects (Covington, 1968). The "Making Judgments" Program developed by Thomas and his associates embedded its instruction in critical thinking in common occupational areas where employees must evaluate information according to known rules or conventions. This program produced a five-unit package on techniques of advertising, causation in research studies, conflict in arguments, evidence and testimony in the courts, and facts and opinions in news reporting (Research for Better Schools, 1979). The lessons were self-programmed books intended to be self-administered and paced and were accompanied by pre- and post-tests. Thomas reports that pilot data showed experimental students outperforming control groups and that interviews with students and teachers and classroom observations indicated a positive reception of the program. An external evaluation of the program by Baker, however, using tests from the program and specially developed criterion referenced tests, showed less clear-cut advantages (Baker, 1975).

Several major curriculum projects, particularly the Illinois and Cornell Critical Thinking Projects, attempted to teach critical thinking as logical reasoning. In the Cornell Project, for example, secondary students received written exercises of 1-2 pages which presented definitions of terms and brief problems asking students to practice such skills as labelling premises and conclusions. No evaluation of the project's effectiveness, use or acceptance by classroom teachers was found in conventional published literature.

Hudgins describes short term (five lessons) programs by two students of Peel that attempt to teach thinking skills to adolescents by having them analyze the logical aspects of verbal problems. The program presented brief exercises and multiple choice questions about their analysis. Both studies showed significant gains by the experimental students over controls, but no evidence of transfer (Hudgins, 1977).

In yet another attempt to teach thinking skills, Edward de Bono devised the CoRT Project which aimed to give teachers a general framework for helping students use particular strategies or tools. These tools are unusual representations of a potpourri of informal heuristics for viewing arguments. The procedures have names such as "the bird watching method" or the "north-south method" in which students are to use a tool called ADI where they look in the direction of Agreement, then Disagreement, then in the direction of the areas of Irrelevance. the instruction uses a "tell, show and do" approach in small group discussion where students respond to a set of problems calling for use of the tool. DeBono described a series of studies of the program with students of various ages. He analyzed protocols of discussion sessions and reported that program pupils made fewer initial and instant judgments and were more inclined to generate points on both sides of a question. De Bono also listed student and teacher comments indicating that students felt they thought more "deeply" during the lessons, were not conscious of using the techniques in their other

school subjects, but did not seem to use the techniques out of school (De Bono, 1976). Tripp also reported a formative evaluation of the CoRT program in which pupils produced more ideas of an apparently higher quality, but closer analysis revealed that, in some cases, these ideas were not generated by using the program's "thinking" tools and that the structured discussions alone, without training on the tool might have produced the results (Tripp, 1980).

A series of fairly recent projects is beginning to receive attention. Among these are Project Impact which focuses on role-playing, problem-solving situations in a local community context, materials based on Guilford's structure of the intellect produced by the SOI Institute, and lessons on strategic reasoning by Innovative Sciences using six problem-solving techniques suggested by Albert Upton.

In general, most of the programs reviewed have not succeeded for a number of reasons. First, most projects, perhaps with the exceptions of Suchman's and Taba's programs, were not accepted as regular courses in the school curriculum. This may partly be due to the development process, i.e., the projects were developed outside the system, and partly because of the artificial nature of the tasks. Second, many projects did not provide sufficient instructional materials and strategies for teachers to use or adapt the programs readily. Third, in many instances the instructional designs of the programs did not seem to use core instructional techniques systematically, particularly instructional cues, and modelling; most programs also did not tend to provide practice and instruction on all aspects of the thinking process, i.e., planning through revising. Most of the programs did not provide instructional experiences of sufficient length and scope to move students through stages of initial skill acquisition, development, and maintenance, let alone, transfer. Fourth, the programs failed to develop or use valid, useful measures of skill development and the instructional process. Without these forms of sensitive documentation, the programs lacked defensible bases for individual diagnosis and monitoring, or for program improvement and validation. Finally, the programs often failed to allow for enough flexibility to accommodate the dynamics of the contextual system in which they operate.

Summary

The task of designing an integrated instructional and assessment system for critical thinking poses a formidable challenge. School systems must decide whether they want to teach critical thinking as generalized or curriculum-embedded skills. Schools must also specify the set of component skills the critical thinking program will teach and test and the range of content and activities in which students will use critical thinking skills. The specified set of skills and tasks can then focus efforts to select or develop appropriate coordinated testing and instructional activities. School systems can draw

upon research from the fields of learning, instruction, and program implementation to select or develop curricula that will offer sufficient guidance, practice and feedback to teach the skills and that will be appropriately tailored to the system and classroom contexts.

Although myriad bodies of research can inform the design of critical thinking programs, systematic study of effective teaching strategies and instructional activities is desperately needed. Efforts such as the Pittsburgh MAP Critical Thinking Project are attempting to use available research to develop such an effective program.

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